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ABSTRACT

The guide describes an assessment procedure that can be used by sparsely populated communities located near a potential development to help predict where the incoming population will choose to live and shop. First, a numerical model, the "gravity model," is presented which utilizes community size and the distance from the community to the development site to determine an "attractiveness factor" which can predict locational decisions of the incoming population. Second, because distance and size will never fully explain people's actions, a list of questions about existing community facilities is provided; the answers can be used to modify the model. The guide suggests that applying the assessment procedure to all communities within potential commuting distance from the development site will result in the expected increase in population in each community, which can be further used to estimate potential growth impacts such as increased public service costs, the demand for new housing, the impact on existing facilities (e.g., water supply and schools), and potential new revenue sources. Instructions for calculating the "attractiveness factor" are included. (BRR)

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Coping with Growth

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Incoming Population: where will the people live?

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Many planned and ongoing developments in the West are located in sparcely populated areas away from existing communities. These include large surface mines, electric generating plants, recreation developments, and some second-home developments. Communities closest to the site often experience growth associated with the development. If more than one community is within reasonable commuting distance from the development site, the impact on each community will depend on where the incoming population chooses to purchase goods and services, and where they choose to live.

This type of locational decision influences growth impacts within a region. For example, a coal-fired electric generating plant is scheduled for construction in rural Nevada. The site of the proposed plant is located in Humbolt County adjacent to Valmy, a small community of 50 people. Valmy provides minimal public services to its residents, and has no retail establishments. The closest "developed" community, Battle Mountain, has a population of 2300 and is located 15 miles from the site in Lander County. Winnemucca, the largest community within reasonable commuting distance to the site (35 miles), is located in Humbolt County and has a population of 3900. If the majority of the 1200 to 1600 people associated with construction and operation of the power plant and provision of services to the power plant work force (e.g., insurance agents, grocers, automobile mechanics) choose to live in Battle Mountain, capital expenditures for schools, water, and sewage treatment plants will be necessary. These expenditures, as well as increased operating and maintenance costs for all public services, must be financed without any tax revenue from the plant, located in adjacent Humbolt County.

On the other hand, if the majority of the incoming population chooses to live in the larger community of Winnemucca, operation and maintenance costs will increase, but the only capital expenditure will be for additional sewage treatment capacity. Funds will be available for these expenditures because Winnemucca is in Humbolt County, which will receive substantial tax revenue from the plant.[1]

Even when growth impacts are limited to one community, locational decisions affect the magnitude and type of impact. For example, if the incoming population is expected to locate within existing water and

[1] Theodore R. Siegler, "Estimated Regional Economic Impact Given the Introduction of a Major New Industry: Procedure and Case Study of a Power Plant Introduced into Central Nevada," M.S. Series, Division of Agricultural and Resource Economics, College of Agriculture, University of Nevada, Reno, 1979.

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sewer districts, increased capacity may be needed. If the incoming population chooses to locate outside these districts, septic systems and wells may be privately supplied by the incoming population, but community costs for police, fire, solid waste collection, and school busing may increase.

When housing is provided at the development site, the choice of where to purchase goods and services again influences growth impacts. In this case, secondary jobs will be created, which also generate growth. The developer of the power plant in rural Nevada cited earlier plans to provide on-site housing for 80 percent of the construction work force. Expenditures by this work force in the two communities will generate between 240 and 320 secondary jobs within the region. As people move into the region with their families, they will locate in the communities where the jobs are available.

Based on these examples, it is evident that an accurate assessment of potential growth impacts depends in part on locational estimates. This publication presents an assessment procedure helpful in estimating the potential location of the incoming population. The procedure consists of two parts. First, a numerical model is presented. Often called the *gravity model*, it relies on community size and the distance from the community to the development site. Second, a list of questions, best answered by local residents most familiar with the region, is provided. The gravity model can be tailored for use in a specific community using answers to the questions. This provides a method of estimating where the incoming population will live and purchase goods and services. Applying the assessment procedure to all communities within potential commuting distance from the development site results in the expected increase in population in each community. A base for further investigation of impacts associated with the development is thus established. For example, information on where the incoming population is most likely to purchase goods and services can be used to estimate secondary employment generated by these expenditures. If housing is not provided at the development site, the procedure can be used to estimate how many new houses must be built, and what effect these houses will have on property tax revenue and public service costs.

The gravity model

The use of the gravity model to estimate the location of people is not new or unique. In *Introduction to Regional Economics,* Hoover tells us that the model was first proposed by William J. Reilly in 1929 to explain his observations on the location of retail trade and population. Hoover also states that:

> John Q. Stewart and a host of others subsequently discovered gravity-type relationships in a wide variety of economic and social distributions. Gravity and potential measures have in fact been applied to almost every important measurable type of human interaction involving distance, and numerous variants of the basic formula have been devised.[2]

Basically, the gravity model assumes that the *attractiveness* of a community (whether for shopping or as a place to live) increases with the size of the community (at least for smaller communities) and decreases with the distance that must be traveled to get to the community. Thus, in the example presented earlier, if Winnemucca and Battle Mountain were the same distance from the work site, use of the model would imply that more workers and their families would choose to shop or live in Winnemucca because it is almost twice as large as Battle Mountain. This is probably true, because Winnemucca has a larger and more diverse shopping area than Battle Mountain, as well as larger schools and better recreational facilities. However, because Battle Mountain is only 15 miles from the work site, while Winnemucca is 35 miles from the site, the greater diversity of shops and better public services may be outweighed by the added driving distance.

The actual estimates depend, therefore, on the effect of distance. Researchers have found that the gravity model seems to describe commuting patterns most accurately if the distance variable is squared. Thus, to determine the attractiveness of the respective communities—or how many workers would choose Winnemucca and how many would choose Battle Mountain—we would perform the following calculations:

Population of Winnemucca = 3900
Distance from work site to Winnemucca = 35
Attractiveness of Winnemucca:
$3900 \div (35)^2 = 3.18$

and

Population of Battle Mountain = 2300
Distance from work site to Battle Mountain = 15
Attractiveness of Battle Mountain:
$2300 \div (15)^2 = 10.2$

We now sum the attractiveness factors

$3.18 + 10.2 = 13.4$

and divide each attractiveness factor by the sum

$3.18 \div 13.4 = .24$

and

$10.2 \div 13.4 = .76$

to derive the percent of the population choosing Winnemucca and the percent choosing Battle Mountain. In this case, use of the gravity model tells us that 24 percent of the workers will choose Winnemucca, and 76 percent will choose Battle Mountain.

The gravity model presented above using the distance squared was developed to explain a wide variety of locational decisions, many involving large eastern cities. It seems reasonable to expect that distance would be less important in the West than in the more densely populated East, and that other factors besides community size and commuting distance would influence locational decisions. Two studies have been done that deal specifically with energy development in rural areas of the West. The first, completed by North Dakota State University, used the basic gravity model, but indicated that people most familiar with the region should modify the model to account for any special characteristics of the region.[3]

The second study was completed by the Old West Regional Commission in 1975.[4] Workers at 14 ongoing energy development sites were surveyed to develop a

[2] Edgar M. Hoover, *An Introduction to Regional Economics,* 2nd ed. (New York: Alfred A. Knopf, 1975), p. 32.

[3] N. E. Toman et al., "Economic Impacts of Construction and Operation of the Coal Creek Electrical Generation Complex and Related Mine," Department of Agricultural Economics, North Dakota Agricultural Experiment Station, North Dakota State University, Fargo, 1976.

[4] Old West Regional Commission, "Construction Worker Profile: Final Report," Mountain West Research, Inc., Denver, Colorado, 1975.

Where will the people live?

Estimating Living Locations for Employees of Large Industrial Developments

	population	÷ (	distance to industrial site	)^{power*}	=	attractiveness factor
Community A	_____	÷ (	_____	)____	=	_____
Community B	_____	÷ (	_____	)____	=	_____
Community C	_____	÷ (	_____	)____	=	_____
Community D	_____	÷ (	_____	)____	=	_____

sum of attractiveness factors _____

	attractiveness factor	÷	sum of attractiveness factors	=	percent population from industrial development to locate in community
Community A	_____	÷	_____	=	_____
Community B	_____	÷	_____	=	_____
Community C	_____	÷	_____	=	_____
Community D	_____	÷	_____	=	_____

* The power (y^x factor on calculators) found to be most accurate in the West is .89. However, it should be increased or decreased if answers to questions provided in the text indicate substantial differences between communities.

method of predicting locational decisions. The gravity model was chosen as the basic model, and statistical techniques were used to estimate the importance of distance in determining where the workers would live. It was found that raising the distance variable to the .849 power (as opposed to squaring the distance variable) best explained locational decisions for energy development in the West. It is interesting to note that workers at energy projects in the West are willing to commute longer distances to live or shop than the basic gravity model would indicate.

Applying the modified model developed by the Old West Regional Commission to the Winnemucca-Battle Mountain example, we find:

Attractiveness of Winnemucca:

$3900 \div (35)^{.89} = 165$

and

Attractiveness of Battle Mountain:

$2300 \div (15)^{.89} = 207.$

Summing the two attractiveness factors

$165 + 207 = 372,$

and dividing each attractiveness factor by the sum yields

$165 \div 372 = .44$

and

$207 \div 372 = .56.$

Based on this modified model, 44 percent of the workers will choose to live and/or shop in Winnemucca, and 56 percent will choose Battle Mountain.

The Old West Regional Commission then reestimated the model by geographic subregions to determine the extent of regional variability. They found substantial variability in the importance of distance. Based on this variability, they concluded (as North Dakota State University did) that

> . . . the community choice model can explain much of the variation in the choice of place of residence, but that the explanation is specific to a particular region . . . (therefore) region-specific characteristics must be taken into account.[4]

Modifying the model for local conditions

The gravity model cannot completely explain locational decisions; individual communities must assess other factors that may be important. Modification of the gravity model based on answers to the following questions should provide a good indication of the proportion of incoming population each community in the region can expect.

(1) What public services are provided, and how do they compare with similar services in other communities in the region? For example, do the schools offer programs that cannot be found elsewhere in the region? Are schools overcrowded with too few teachers? Are there recreational activities—such as a municipal swimming pool—that are not provided in other communities? How do health-care facilities compare with those in other communities in the region?

[4] Toman et al.

(2) How developed are private services (specifically retail services) in the community? Often the availability of a wide range of retail services is synonomous with size. In some cases, however, other factors may be important. If a major highway runs through a community, it may stimulate greater retail diversity than a community of similar size without the highway.

(3) What are commuting conditions like from the work site to the various communities in the region? A community twice as far from the work site may be preferable if the closer community can only be reached by driving over a mountain pass.

(4) Is adequate housing available? If not, are adequate housing sites available, and are local contractors available to construct housing?

(5) Are any communities closer to a major trade area that supplies special services not available elsewhere in the region?

(6) Does the community—especially its elected officials—want new people? If so, will an effort be made to provide adequate services for the incoming population?

These questions were applied to the Winnemucca-Battle Mountain area. It was determined that Winnemucca had larger, uncrowded schools (while all of Battle Mountain's were 20 percent over capacity), better recreational facilities, a larger health care facility with more doctors, and more retail shops. Therefore, it was estimated that at least 44 percent of the workers with families would choose to live in Winnemucca, and a second case assuming 54 percent of the workers and families would choose Winnemucca was also analyzed.

Location within the community

Once an estimate of the proportion of the incoming population choosing to move to each community in the region has been made, consideration can be given to location within each affected community. No models are available to assist in this problem. Judgment must be used based on at least three factors:

- An assessment of the **current availability of housing** in the community should be carried out. This will indicate how much of the incoming population will be able to find existing housing, and where it is located.
- **Available approved housing sites** should be examined. These sites, in conjunction with any land use plans and zoning regulations that restrict development, will indicate the most likely areas for additional development.
- An assessment should be made of **where building is presently occurring** around the community.

Conclusions

This publication describes an assessment procedure that can be used by communities located near a potential development to help predict where the incoming population will choose to live and shop. The procedure relies primarily on a numerical model, using community size and distance to the development site to predict locational decisions of the incoming population. Because distance and size will never fully explain people's actions, each community must also take into account some key questions about the community, and modify the model based on answers to these questions.

The results of the assessment, while not providing exact answers, can still aid in the estimation of such potential growth impacts as:

- **increased public service costs**
- **the demand for new housing**
- **the impact on existing facilities (e.g. water supply and schools)**
- **potential new revenue sources.**

If a community has outside assistance in estimating development impact, it should make sure that locational estimates are clearly defined in the impact report.

References

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